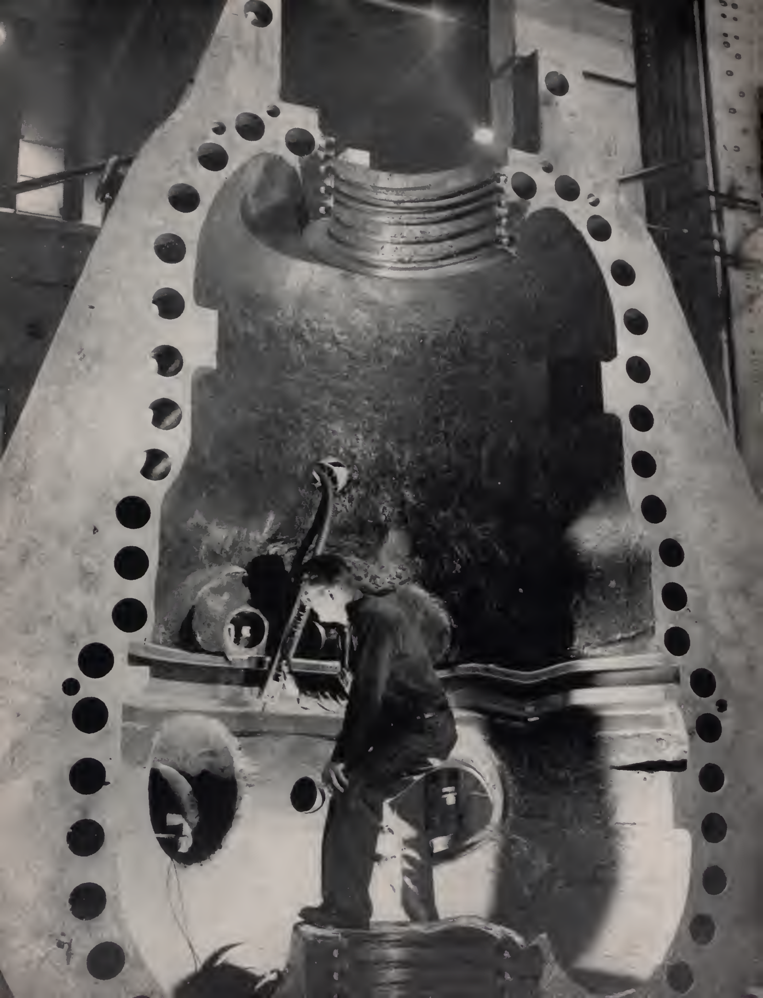
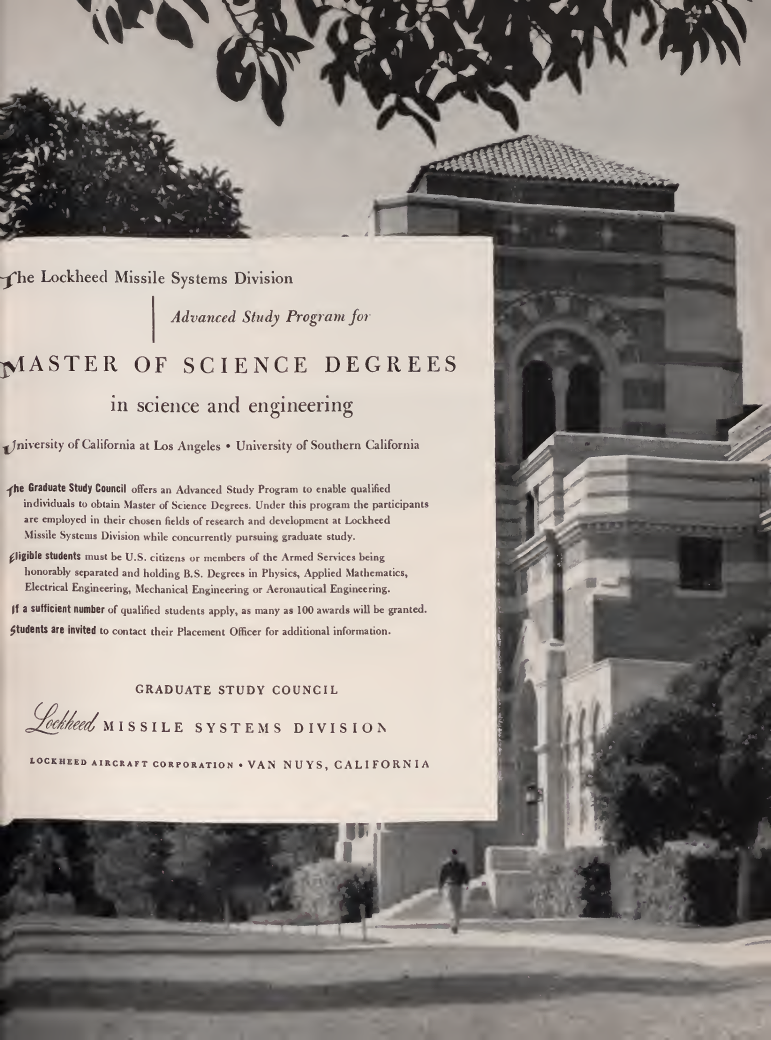
the Mecheleciv

VOL. 15 NO. 2

SCHOOL OF ENGINEERING
THE GEORGE WASHINGTON UNIVERSITY

NOVEMBER 1955

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VOL. 15 NOVEMBER 1955 NO. 2

SCHOOL OF ENGINEERING, THE GEORGE WASHINGTON UNIVERSITY

IN THIS ISSUE

DEPARTMENTS

ON OUR COVER

Modern equipment is the keynote of the Electronics Devices Laboratory, now housed in the Mechanical Engineering Annex. Three students are seen here investigating the characteristics of a multivibrator circuit.

FRONTISPIECE

The machining of a steam turbine shell is a large operation; the fifteen foot long, 53,000 pound shell is shown being machined to size on a horizontal boring mill. The shell belongs to one of a battery of turbines being made by the General Electric Company for the Cleveland Electric Illuminating Company; the finished unit will be rated at 260,000-kva.

Photo courtesy of GENERAL ELECTRIC

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THE AUTOMOTIVE SIMULATOR

By Earl Bass BEE 54, MSE Candidate

EARL BASS is employed, as a publications engineer, by the Engineering and Research Corporation of Riverdale, Md. His duties consist mainly of the preparation of handbooks for the operation and maintenance of electronic flight simulators. Earl is not a newcomer to these pages on the subject of computers; his article "The Instructor Was An Analogue Computer" appeared in the November 1954 issue of the MECHELECIV.

The use of electronic computing systems is a comparatively new and rapidly expanding field. Digital and analog are the two broad categories of computers that are in common usage. The digital computer has become widely publicized through the so called "magic brains." The analog computer, on the other hand is not as highly publicized and few people outside the engineering field know its theory of operation or its capabilities.

An analog computer is a device which solves mathematical equations by allowing voltages of the proper magnitude and phase to represent the involved quantities. By adding, subtracting, multiplying, integrating or differentiating these voltages, a resultant voltage is obtained whose magnitude and phase represent the solution of the equation. The following discussion presents a basic explananation of the theory involved, followed by an example of a simplified analog computer.

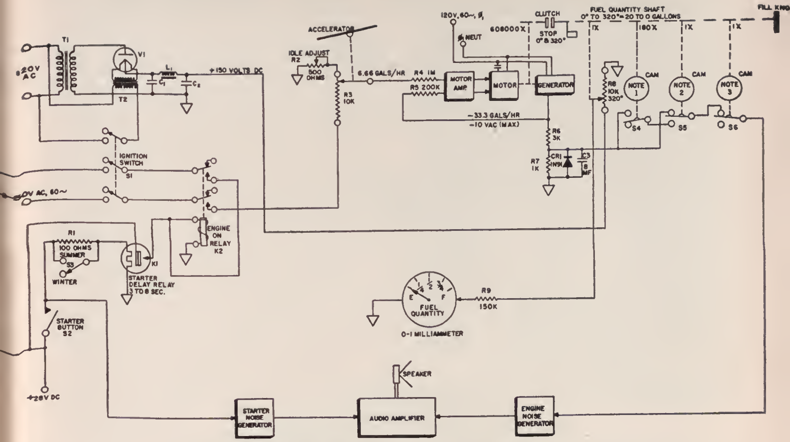
One of the basic components of an analog computer is an amplifier whose gain is maintained constant by large amounts of inverse feedback. If a 60 cycle 10 volt signal is fed into an amplifier that has been adjusted to unity gain the output voltage will also be 10 volts. If a second 60 cycle voltage is introduced at the input of the amplifier the two voltages will add. If the second voltage is 4 volts and in phase with the first voltage, the output will be 14 volts. The actual addition of the two voltages occurs at the input of the amplifier, but the amplifier (usually called a summing amplifier) is essential as it permits the resultant voltage to be usable without affecting the accuracy of the addition. This is accomplished by using an amplifier with a high input impedance, therefore providing a negligible loading effect on the input signal source.

Subtraction is merely negative addition and is produced in the same way. Consider that the 4 volt signal in the previous example is 180° out of phase with the 10 volt signal. Now the resultant "added" voltage will be 6 volts..

Multiplication can be accomplished in a variety of ways. The simplest method requires the use of a linear potentiometer. In this type of multiplication the voltage applied across the potentiometer is one factor and the degree of wiper arm rotation is the other factor. If the wiper arm is located at a point equivalent to 50% of the total resistance, the voltage at the arm will be exactly one half the voltage impressed across the potentiomter. Now if the voltage at the arm is fed through a summing amplifier with a set gain of ten, the output voltage will be 5 times the voltage across the potentiometer. If the wiper is rotated through 1/4 turn (.25), the voltage at the output will be 2.5 times the voltage across the potentiometer. It can be noted that the output of the potentiometer alone is a sub-multiple (or division) of the impressed voltage (½ or 1/4 in the examples given) while the summing amplifier moves the decimal point.

Trigonometric functions are also easily obtainable in an analog computer. A variable transformer or goniometer is the simplest method of obtaining sine or cosine functions. If both coils are parallel, maximum induction takes place and assuming that both coils are identical the output voltage will be equal to the input voltage. As the output coil is rotated, the voltage across it decreases until, at 90°, the voltage will be zero. The rate of voltage decrease varies as the cosine of the rotated angle. The sine function is numerically equal to the cosine function but shifted 90°. Therefore an initial shift of 90° will produce sine functions as the coil is rotated. In fact, two coils mounted 90° from each other can be rotated simultaneously and the input voltage times the sine of the angle rotated will be produced at one coil and the cosine function at the other. Since a device of this kind can resolve a given voltage into its components the unit is usually called a resolver.

Integration is more readily visualized if an example is used. An automobile speedometer is a type of mechanical integrator, i.e., the input is miles per hour or rate of change of distance and the milage indicator reads miles or distance. Electro-mechanically an integrator shaft is designed to continuously represent the integral of a voltage as a position of the shaft. To do this, it is necessary to have a motor whose speed varies directly with input voltage. Motors normally do not offer this relationship but used in conjunction with an amplifier,



Schematic Diagram of the Automotive Simulator

and a generator to produce inverse feedback, proper results are obtainable. For example, if a signal of 10 volts representing 200 miles per hour were fed into the integrator and if the shaft speed is such that the shaft angle advances 100° in one hour, then 100° represents the distance traveled in one hour, or 200 miles. If the speed were increased to 400 miles per hour, the shaft would turn 100° in one half the time of the above example, or in half an hour. Since the input voltage represents a velocity and the shaft rotates at a speed proportional to this voltage, the shaft angle at any instant is a measure of the distance traveled, i.e., the integral of velocity is distance.

Analog computers can be put to many uses, one of the largest fields probably being that of training aids. The following discussion affords a practical example of the simulation of a familiar situation, the depletion of fuel from the tank of an automobile as the engine runs. All factors have not been considered — just enough to give a general idea of the system.

The approximate quantity of fuel present in the gasoline tank of an automobile is indicated to the driver by the fuel gage on the dash board or instrument cluster. Suppose that it is desired to actuate this instrument in a realistic manner in an automobile containing all interior controls but having no actual engine or gas tank. Some of the things that have to be taken into account are as follows:

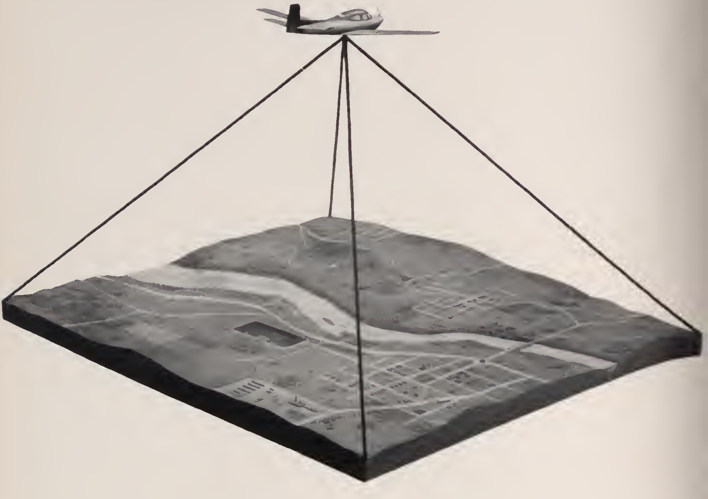
a. The car must not "start" unless the ignition key is turned on.
b. When the ignition key is turned on the fuel quantity gage should (in most cars) move gradually from the "empty" position up to the position indicating the present level of fuel.
c. The starter button must be pressed and held for a short period of time until the engine "fires." This time may be longer than usual in cold weather.
d. Once the engine is started the rate of fuel depletion should be proportional to accelerator position. Maximum (wide open) and minimum (idling) rates of consumption must be established.
e. "Starter" and "engine" sounds should be heard. The "engine" sounds should vary with engine speed and should splutter just prior to the time when the fuel is exhausted; all sound should then cease.

A computer designed to satisfy these requirements is shown on the accompanying figure. The driver's controls are: the acelerator, the starter switch and the ig-

(*Please turn to page* 24)

THE FACE OF THE EARTH IN 3-D

By Ray Sullivan, BEE '58



Surveying is usually thought of as involving men dressed for rugged outdoor life who carry transits, leveling rods, and other paraphernalia through forboding wilderness country in all kinds of weather for weeks or months on end collecting detailed information in little notebooks. You can imagine the surprise of any surveyor who passed from the scene more than a few years ago if he were to return to see the saving of time and elimination of much of the field work through use of the relatively new technique of topographic photogrammetry. Using this technique, a plane in which is mounted a specially designed camera flies over an area at a predetermined altitude and several overlapping pictures are taken. These pictures are developed and printed and photogrammetrists working with stereo-optical equipment in a pleasant weatherproof office can do much of the work that formerly fell to the lot of surveying parties in the field.

Aerial photography is used for many things other than surveying. Aerial photographs aid tax assessors in evaluating property and assist in exploration, military reconnaissance, visual education, and traffic studies. Exact measurements can be made of bulk material storage piles such as coal or iron ore piles with a combination of accuracy and economy that exceeds any other practical method.

Topographic photogrammetry is not intended to provide the degree of accuracy of geodetic instruments. It does, however, provide advantages of speed, economy, freedom from large errors, and furnishes a complete, detailed, and permanent record of the area.

There are two firms in the local area which specialize in topographic photogrammetry: Air Survey Corporation and Alster and Associates. Air Survey Corporation prepared topographical maps for the northern end of the New Jersey Turnpike in 1947. The aerial pictures were taken just a few days before the well-rememberd blizzard of 1947 completely covered the area being considered and stopped preliminary work on the turnpike. However, Air Survey had already "brought the outdors inside" and while the snow was melting off they had their photogrammetrists on the job. When the location study was resumed, Air Survey turned in completed maps.

Alster and Associates surveyed the site of the Air Force Academy at Colorado Springs, Colorado. The project required a "1 inch equals 400 feet" map with 5 foot contour intervals for a total area of 35,000 acres and a "1 inch equals 100 feet" scale map with 2 foot contour intervals for a 20,400 acre portion within the 35,000 acres.

In most cases, the first step in undertaking an aerial survey is the taking of the pictures but this includes a certain amount of preliminary work. The mapping crew must study available maps of the area to be flown to establish the starting point and direction of each flight line in relation to indentifiable features on the ground. The proper flight altitude must be determined to provide the scale of map desired. Something should be known about conditions in the area to be surveyed because things such as smoke, haze, clouds, leaves on trees, snow, and long shadows due to the sun being low in the sky detract from optimum picture quality.

When the preliminary work is completed and the photographic plane takes off, the quality of the photographic coverage is dependent on the skill and attention to detail of the pilot and the cameraman. The pilot's job is to see that the plane is flown at the proper altitude and on course and that there is a minimum of tilt and crab. The cameraman must see to it that all of his equipment is easily accessible and that the camera is properly adjusted for the speed of the film, atmospheric conditions, and other technical considerations.

When the photographic flight is completed the film is developed and prints are made of each shot in preparation for the next phase of the sequence which is the establishing of the ground control net. This is done by conventional surveying methods and the points selected as appropriate for the unique requirements of aerial photography are "tied into" the horizontal and vertical control stations established by the national surveying agencies. The ground control points for aerial mapping may be such things as center lines of crossroads, field corners, or railroad crossings.

Photogrammetrist at work.

The big advantage of aerial photography as used for topographic surveying lies in the "3-D" effect. This is brought about by the fact that any given element of area is covered by two overlapping pictures. When these two pictures are viewed with the aid of stereoscopic (3-D) instruments the area of overlap appears in relief.

One of the common methods of mapping from aerial photographs involves a photogrammetric instrument known as a "multiplex." The multiplex consists of a large table with a metal frame over it on which are mounted two or more projectors. Each projector contains a glass plate on which is reproduced one of the pictures in a strip. The adjacent projector contains the adjacent picture of the same strip. The pictures are projected down to the table top in such a manner that they may be viewed stereoscopicallv on the table or on a small viewing screen. The projectors must be in such position and orientation as to reproduce exactly the conditions existing at the moment the picture was taken. In other words, the projectors must be raised or lowered, turned on the vertical axis, and/or tilted to correct for any momentary differences of the elevation or flight attitude of the aircraft at the moment of taking the picture.

(*Please turn to page* 26)

A NEW APPROACH

By John A. Cannon BME 56

JOHN CANNON, in his first contribution to these pages, writes on a subject with which he is extremely familiar through his position as an engineer for the Potomac Electric Power Company. John is a senior in Mechanical Engineering and in addition to holding down a full-time job and taking night courses, is the president of the G. W. A. S. M. E. chapter.

There are many times when an electrical system with a heavy inductive reactance load requires the use of capacitive reactance to reduce the I^2R losses and to establish equilibrium conditions throughout the network. Theory and practice have established that alternating-current synchronous generators may be used as synchronous condensers or capacitors when placed across the line and synchronized to the phase and frequency of the alternating current present. In the past, this corrective addition of capacitance has been accomplished by disconnecting or uncoupling a synchronous generator from its driving turbine, placing it across the line requiring the capacitive reactance, and, after it has been brought up to a certain speed by "motor effect," synchronizing it to the frequency of the line.

This application of a synchronous generator to obtain synchronous capacity adequately succeeds in offsetting the effects of a heavy inductive reactance load on the system. However, should the power demands on the system suddenly exceed the power producing capabilities of the generators feeding the line, some source of reserve current must necessarily be instantly activated and fed into the line to meet the emergency. The generator being used as synchronous capacity cannot be quickly converted to a power source because it is in rotation and uncoupled from its driving turbine. To convert this generator from a source of capacitance to a source of power would be far from an instantaneous process. It must first be disconnected from the line and brought to a stop. The driving turbine must then be coupled to the generator, steam fed to the turbine, and, after the unit comes up to speed, it must be synchronized and placed across the line as a power source.

To become an instantaneous source of power reserve when it is in operation as a source of synchonous capacitance, the generator shaft would have to be coupled to the turbine shaft at all times. The "motor effect" which rotates the generator when applied as capacitance would also rotate the turbine at the same time, thus providing a load reserve in an already spinning form. The conversion of the generator from a source of capacitance to a source of current would require only the admission of steam to the turbine and the proper electrical loading of the generator.

In the past, this couldn't be done. Joule's "paddle effect" caused internal heating within the turbine which, if left unchecked, would rise to the point where permanent damage to the turbine blades and other components would result. The decided heating is produced by the turbine acting as an axial compressor of extremely low efficiency. It churns the small percentage of steam resulting from normal leakage and the normal quantity of air which exists in the turbine casing in much the same manner as the paddles churned the water in Joule's barrel when he was experimenting in search of the mechanical equivalent of heat.

However, if the overall volume within the turbine were to be evacuated to a high degree of vacuity, the drag on the generator and the dangerous heat produced by the churning of the air and steam normally within the turbine would be reduced to a minimum. This vacuity condition would permit the generator and the turbine to remain a unit on a single shaft, giving to the system a floating power reserve when the generator is used as a synchronous capacitor.

The General Electric Company's Marine Division recently completed some experiments in connection with operating turbines in a vacuum with varying degrees of the normal quantity of steam supplied to the machine. These experiments determined accurately the degree of the intense heat that could be produced by the "paddle effect" of turbine blades churning the relatively "thick" atmosphere within the casing. They found that in a 96% vacuum the temperature within the evacuated space rose to 570 degrees F. within eight minutes under normal temperature and steam leakage conditions. When 12% of the normal steam quantity was admitted to the evacuated space the temperature rose past the 930 degree F. level in less than a minute. At this point, with a 66% vacuity condition existing in the casing, the blades on a reversing turbine became blue. The metal had undergone exterior oxidation due to the high temperature. This data shows both the feasibility and danger of spinning a turbine in a vacuity condition. As the overall volume approached the pure vacuum level and with a minor quantity of steam included in the casing, the heat produced approached an allowable, operational level. However, when 66% vacuity and 12% normal steam content existed within the turbine, the immediate, dangerous rise in temperature points to the rapidity with which the entire machine could be destroyed.

The series of experiments indicates the necessity of exercising extreme care and of obtaining accurate "running" data when testing or actually operating a turbine

in vacuity.

The magnitude of the destructive potential inherent in the turbine can best be demonstrated by recalling the Ridgeland Station disaster. This part of the Commonwealth Edison system exploded on December 17, 1954, killing two men, injuring five others and causing property damage in the neighborhood of $10,000,000. Pieces of the 100,000 KW steam turbine were found hundreds of feet away from the station. This tragic accident is believed to have been caused by a defect in the main shaft casting, though the resulting shambles allowed only speculation as to the actual flaw.

The instrumentation required in any development project is of crucial importance. In this instance, the steam turbine tested should have approximately 50 thermocuples for a 17 stage turbine with the following complement of instruments: four differential expansion recording indicators, eccentricity indication recorders, vibration recorders, internal sonic recorders, steam pressure recorders, steam temperature recorders, net load recorders, power-factor recorders, exhaust steam pressure recorders, exhaust temperature recorders, and interstage pressure and temperature recorders.

The Consolidated Edison Company has pemitted vacuity experimentation on a 15 MW Westinghouse, a 40 MW General Electric, a 60 MW General Electric, a 40 MW and a 60 MW Westinghouse turbine generators. These units have been operated up to 80,000 hours or the equivalent of nine years of operation without mishap.

These experiments showed that, if the turbine is operated in a mildly evacuated condition, the rotational losses of the machine produce a decided heating of the churned steam as the turbine acts as an axial compressor of low efficiency. The large residual velocity energy produced in the rotating wheel is destroyed most in the following guide buckets or nozzles because of the impact on the guide nozzles which converts this energy to heat. These losses which are created by fluid friction, blade and nozzle loss due to the friction on the blades, leakage around the packing and seals, and leakage around the blade tips may be reduced by the design of multiple turbine elements. This may seem to be a paradox; the increased number of elements could cause increased losses. However, this is a situation where it is reduced. The use of dual, triple, or quadrature flow ("staging") assists in the dissipation of heat which may create dangerous or prohibitive localized temperatures in the turbine or steam condenser.

It was also learned that line floating permits a decrement of temperature due to radiation in vacuity to 30 degrees F/hour which permits 20 hours for a 600 degree F. variation. The maximum blade tip temperature was finally limited to 170 degrees F. which is a reasonable limit, but any reduction would be a welcome occurence that only time and study will develop.

The answer to the heating problem within the turbine lies in reducing to zero mass — or as close to that value as is possible — all space within the turbine not actually taken up by metal.

A practical example of the evaluation of a standard turbine generator and the initial computations will be given here to facilitate visualising a method of procedure in determining the practicality of establishing experimental work: we take a 40,000 KW AIEE-ASME standardized turbine generator unit with a 40,000 sq. ft. condenser having 7/8" O. D., 26 ft. active length tubes, and a normal set of heaters and evaporators. The casing, from governor value to the exhaust flange, has a net volume of about 750 cu. ft. Assume the heaters, evaporators, and piping have 20% additional volume, or about 150 cu. ft. The condenser shell, steam inlet, and hotwell have a net volume, exclusive of tubes, of approximately 5,500 cu. ft. This totals 6,400 cu. ft. and each pound of air at atmospheric pressure occupies 13.3 cu. ft. Therefore, there is contained in this equipment approximately 480 pounds of air. To evacuate to 15" Hg. absolute requires 240 lbs. to be removed and to evacuate to 1/2" Hg. requires the removal of approximately 472 lbs. of air. The turbine is then free to float in a total of 8 lbs. of air distributed throughout the overall volume. Assume 70 degrees F. as condenser air temperature.

Eample:

$$P.\ V. = w.\ R.\ T.$$

$$14.7 \times 144 \times 6400 - 480 \times 53.36\ (70^\circ + 460^\circ)$$

$$940{,}080 \times 144 =$$

$$13{,}547,\ 520$$

$$28249$$

$$= 480 \text{ lbs. of air} = w.$$

$$P.\ V. = w.\ R.\ T.$$

$$144 \times 0.25 \times 6400 = w^2 \times 28{,}249$$

$$w^2 = 8 \text{ lbs. of air}$$

$$6400 \text{ cu. ft.}$$

$$8 \text{ lbs.}$$

$$= 800 \text{ cu. ft./lbs. of air}$$

If we assume further that we have a 230° F. rise or an equivalent decrease in vacuity the following pressure within the machine space will exist:

$$P.\ V. = w.\ R.\ T.$$

$$144 \times 6400 \times P = 8 \times 53.3 \times (300 + 460)$$

$$921,\ 600 \times p = 8 \times 53.3 \times 760$$

$$P =$$

$$324{,}064$$

$$921{,}600$$

$$P =$$

$$0.35 \text{ lb/sq. in. absolute}$$

Assume a 30" Barometer and a 29.44 Hg. Vacuum and we have 0.56" Hg. back pressure or 0.56 x .491 = 0.30 psi absolute pressure with machine space which compares favorably with the 0.35 lb/sq. in. absolute above.

The use of steam turbine-generators as spinning or floating capacitors will permit a definite amount of spinning reserve capacity. This is accomplished by utilizing the stand-by steam generator or boiler as a steam accumulator which is kept at full pressure with adequate auxiliary equipment mobilized for practically instant loading of the spinning turbine-generator when the throttle is tripped open. This will permit almost instantaneous loading whenever an electrical system emergency occurs.

The experimentations with floating steam turbines will be an absolute necessity in a Naval Aircraft Carrier utilizing steam turbine propulsion equipment or utilizing steam turbine driven electrical generators for supplying electric motor-driven propulsion equipment. In the light of these demands, the Westinghouse Electric Corporation has recently opened steam laboratories in Philadelphia to expedite the development of improved initial designs in all steam apparatus for the future.

Out of the

ON CAMPUS

Dr. Walters Joins Faculty

Once upon a time (that's the way all good stories begin) your correspondent climbed a rickety flight of stairs, walked down a narrow corridor, entered a tiny book-lined room and met a most amazing man by the name of Dr. Jack Edward Walters.

After a courteous welcome and a little verbal sparring, Dr. Walters admitted he has a Ph.D. in engineering from Cornell and a BSME and MSME from Purdue where he was Director of Personnel. While your correspondent sat in silence trying to think of an appropriate question, Dr. Walters, divining his state of mind, dived into a drawer of his desk and emerged with a triumphant 'voila" and a sheaf of press releases which will be paraphrased forthwith.

Dr. Walters was appointed last Spring to continue the development of the Engineering Administration Program at George Washington which leads to a Masters in Engineering Administration.

Formerly Professor and Chairman of the Engineering Administration Department at Rutgers University, Dr. Walters is prominent both as the author of several books dealing with the subject of administration and as a management consultant to industrial concerns.

In addition to the three degrees which he has taken at Purdue and Cornell, he has studied at the University of Chicago, Indiana University and the University of Dijon, France.

'I have one hobby — painting' said Dr. Walters in answer to a question put forth by your correspondent and to illustrate this he pointed out the excellent oils encircling his room.

'Which do you like best?' he queried. When y.c. pointed one out he said 'Ah, Ha, that proves you are a modernist,' which was all very disconcerting as y.c. has always thought of himself as old-fashioned. When asked to select one off another wall y.c. was more careful and this one proved him to be an engineer.

Dr. Walter admits he has little time for painting now, however. In addition to heading the Department, he is teaching three courses this semester, Management for Engineers I and II, Engineer and Society, and Problems in Engineering Administration.

He is a member of the A.S.M.E. and is presently Secretary, Research Committee on Engineering Administration of the organization. He also belongs to the American Management Association, the Society for the Advancement of Management, The Industrial Relations Research Association, and is the former President of the American College Personnel Association. His fraternal affiliations include Tau Beta Pi, Pi Tau Sigma, Phi Delta Kappa, and Sigma Chi.

ASME

The 56 members of the ASME were treated to a Perfect-Circle movie on the Indianapolis "500" at their October meeting. Rules and regulations governing the chapter prize paper contest were announced. The contest provides a $50 award to the best student paper at G. W., with the winner given the honor of presenting his paper at the Regional Convention at Syracuse.

The 1955 Mixer

Lisner Auditorium was the place; October 7 was the date; 8:30 was the time; it was the 1955 Engineers' Mixer. This annual affair, sponsored by the Engineers' Council, is to acquaint the engineering students with their faculty on an informal basis. To further this goal, the Council gave a skit depicting members of the faculty, thus giving the students the "low-down" on their instructors. In conjunction with this novel approach to the mixer the Council, for the first time, published an Engineers' Calendar which is now being distributed on the Engineering Campus.

THETA TAU

Gamma Beta Chapter of Theta Tau initiated the following men on October 8 at a ceremony in Lisner Auditorium: Mickey Booth, Reginald Charlwood, Howard Davis, Joseph Greblunas, Ronald Hollander, Orrin Kee, Robert Knowles, Tony Lane, Donald Letzkus, Sy Matthews, George McConnell, Dick Rumke, Robert Shuken, Maurice Spencer, Jim Sullivan. In the evening, the semi-annual banquet and ball was held at the Occidental Restaurant. The new members presented a skit on Prof. Walther's classes, and Maurice Spencer won the slide-rule award for the best Theta Tau gear.

AIEE-IRE

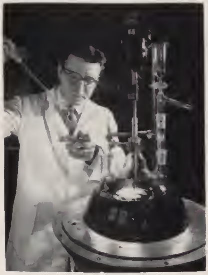
On October 5, the AIEE-IRE heard Dr. John P. Hagan of NRL give a slide-movie-blackboard talk on Radio Astronomy. Dr. Hagan is internationally known for his work in this field and has recently been appointed to the satellite project. Refreshments were served following the meeting.

(Please turn to page 16)

Briefcase

IN INDUSTRY

New Insulation



A new insulating enamel has been introduced by Westinghouse Research Laboratory, promising smaller, more efficient and more lasting electrical equipment.

The new enamel has been life-tested, showing that electric motors using it for insulation can operate for ten years at a temperature of 325°F!

And, for the chemical-electric-minded student: the new insulating material is a modified polyester type resin containing about 20% silicone.

"Dirt" Gets Put In Its Place

Dirt, that sometimes destructive sometimes productive substance has been shortening the life of our clothes since the first time we wore them. Scientists are constantly studying the mysterious forces which hold dirt to cloth, yet which are broken down by use of such common ingredients as detergents, mechanical agitation, and water temperature.

The current technique is to "tag" dirt with radio-active carbon and trace it through a cleaning cycle. Any one of dirt's three essentials can be tagged for study: carbon black, fat, or protein. The radioactivity of the stain is measured before cleaning, then afterward, and the difference in beta-particle emission accurately measures the amount of the tagged ingredient removed.

More Brain Power

Officials of Lockheed Aircraft Corporation disclose that the newest addition to the nation's mechanized brain power is busily solving complex aerodynamic, stress, and flutter problems on new-type Lockheed airplanes.

The brain can remember a number (that is, find its address on the drum) in less than three-thousands of a second — truly supersonic speed. It can add and subtract 10-digit numbers at the rate of 200 a second, make 60 multiplications a second and divide at virtually the same speed.

Known as an "IBM Type 650 Magnetic Drum Calculator," the new machine was made by International Business Machines, Endicott, N. Y.

A team of highly-trained mathematical analysts feed the brain with punched cards and put it to work each day. To solve problems, they must translate the problems from the language of physics and mathematics to the language of the machine, and instruct the machine as to data and solving procedure, all by feeding in the punched cards.

Educational Aid

Eastman Kodak Company and North American Aviation, Incorporated have announced new aid-to-education programs to begin this current year.

Kodak will provide financial grants to some fifty privately supported colleges and universities whose graduates are employed by the company. North American's program is for children of employees, combining student scholarships and cost-of-education grants to private colleges and universities attended by scholarship winners.

Kodak grants made in 1955 will be based on the number of graduates employed in 1950 and still employed.

This 20,000-kva highway mobile transformer, the world's largest, is shown being readied for shipment to the Texas Power and Light Company in Dallas. The transformer, built by Westinghouse, will serve in maintenance operations.

it takes many engineering sk

McDonnell "Voodoo", *the most powerful jet fighter ever built in America.*

MECHANICAL ENGINEERS are concerned with many phases including experimental testing and development, mechanical design, stress and vibration analysis, combustion research, heat transfer and nuclear reactor development.

J-57 POWERED AIRCRAFT

MILITARY	
F-100	F8U
F-101	A3D
F-102	B-52
F4D	KC-135

COMMERCIAL

Boeing 707

Douglas DC-8

AERONAUTICAL ENGINEERS work on innumerable internal and external airflow problems concerned with design, development and testing of aircraft powerplants. Some who specialize in analytical engineering forecast engine-airplane combinations a decade in advance of design.

ELECTRICAL ENGINEERS directly contr their specialized skills to the analysis development of controls, systems and s instrumentation. An example is the "P mat" which automatically integrates and pressures, temperatures and air angl performance testing.

create the top aircraft engines

An aircraft powerplant is such a complex machine that its design and development require the greatest variety of engineering skills. Pratt & Whitney Aircraft's engineering team has consistently produced the world's best aircraft engines.

The best planes are always designed around the best engines. Eight of the most important new military planes are powered by Pratt & Whitney Aircraft J-57 turbojets. The first two jet transports in the United States will use J-57s. Further, no less than 76 percent of the world's commercial air transports are powered by other Pratt & Whitney Aircraft powerplants.

Such an enviable record can only be built on a policy which encourages, recognizes and rewards individual engineering achievement.

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Division of United Aircraft Corporation

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World's foremost designer and builder of aircraft engines

MICAL ENGINEERS, too, play an important . They investigate the chemical aspects of t-producing and heat-transferring mate-s. This includes the determination of se and equilibrium diagrams and exten- analytical studies.

METALLURGISTS investigate and develop high temperature materials to provide greater strength at elevated temperatures and higher strength-weight ratios. Development of superior materials with greater corrosion resistance is of major importance, especially in nuclear reactors.

WORLD'S MOST POWERFUL production aircraft engine. This J-57 turbojet is in the 10,000-pound thrust class with considerably more power with afterburner.

On Campus

(Continued from page 12)

First MEA Degree Given

D. G. Schinke receives MEA degree from Dean Mason.

On June 8, Douglas G. Schinke, Lt(jg) USNR, became the first student to receive the degree of Master of Engineering Administration in the newly developed program of the School of Engineering. The program, introduced in the fall of 1954, is set up with close coordination with the Navy Department to train engineers and scientists in fields of administration and management.

MECHELECIV At ECMA

Editor Mike Brady and Associate Editor Ray Sullivan represented MECHELECIV at the Engineering College Magazines Associated Convention at the University of Nebraska in Lincoln on October 6, 7 and 8. The program for the annual convention included a review of the year's activities and discussion with professionals on the problems encountered in Engineering College Magazine publication.

At the E.C.M.A. banquet, prizes were awarded to the almost 40 member magazines represented; MECHELECIV was awarded a Third Place Award in the Student Story Division for "How to Build a Resonant Frequency Bathroom," by Guerdon Trueblood, which appeared in the April, 1955 issue.

Faulkner, Kingsbury & Steinhouse—Architects

TOMPKINS

Even the most casual reader of these pages might think that by running another article on Tompkins Hall we are being repetitious: we are. To say the least, Tompkins represents the greatest single event that has occurred in the engineering school for the past few years. The fact that the building was donated to the school places it in a unique position as far as the engineering physical plant is concerned. MECHELECIV has continually endeavored to bring to its readers up to date news on engineering school activities; it is in this vein that this summary is presented. MECHELECIV is indebted to many parties for material in this article and wishes to take this opportunity to thank the President's Office for the Architect's sketch, Dean Mason for his assistance in compiling information and Sy Matthews for gathering the details on the finished structure.

FUTURE IN THE MAKING

At its present stage of construction, only the most familiar of construction engineers would be able to see the finished Architect's sketch in the sea of mud, concrete forms and churning concrete mixers that now is Tompkins Hall. Doubtlessly the entire engineering school will watch, as they have in the past, the progress of construction until the building is ready for 1956 fall term classes.

Since even the most optimistic of faculty and student body in the engineering school are awaiting an actual tour of the structure, MECHELECIV has dug into the pot of available facts and come up with, in almost genie-like fashion, a deluxe tour of Tompkins.

The leaves crunch under our feet as we walk east on G Street toward 23rd (the parking situation has not yet been solved); it is the fall of 1956 and the day of the opening of Tompkins Hall. The view from 23rd and G is spectacular: there is no Draper Hall or Building X, and in their place is a modern four-story limestone and glass structure, that is in its every line an engineering building. We enter through large glass doors opening onto the first floor and walk south past offices to the E.E. lab door. The two E.E. labs facing the rear of the building are large: along with their associated instrument room they span the 140 foot length of the structure. An old student will readily recognize many old friends in the lab equipment, but there will also be many new "strangers," machines and equipment to keep the E.E. student abreast of the most modern developments in his field. At the north end of the building we note a vibration, ever so slight, yet indicating the presence of heavy machinery. We soon find that the basement below us houses the heating plant, the heat and power lab, the materials lab and associated small rooms. If, at this time, we had a set of blueprints in our hands, we could see the extensive heavy foundations that support the huge power and testing machinery. Equipment is available here to test power devices and the properties and strength of materials.

The concrete labs on the mezzanine are our next stop. Here complete facilities for the testing of concrete are provided by testing devices used in conjunction with a moist room to test the wet and dry strength of concrete. Almost as if there have not yet been enough labs, we now peek into the fluid mechanics lab, and on our way to the second floor we walk past two computation rooms and a seminar room.

No longer is classroom space at a premium, for on the second floor are four classrooms, two of which are equipped for audio-visual work. Labs seem to abound, for here are four more: a soil mechanics lab, a stress-analysis lab, a U.H.F. lab and two small instrumentation labs. Up to this point, Tompkins seems to have satisfied the Dean, for he has an office on the first floor, and the students, for they have ample laboratory space. As we walk down the corridor of the third floor, we observe that the faculty must also be pleased with their eight new offices facing the front of the building. Again more classrooms: there are seven facing the rear on this floor, and there is yet another floor to go!

Any student who has ever gone through the pains of drawing in X or Draper will certainly applaud the new

The completed basement and first floor deck show the final form of the building.

drawing lab on the fourth floor. Equally pleased should be the graduate students, who have four labs and a seminar room reserved for their use. The antenna lab is also located here in its most logical spot: close to the roof where antennas might be placed.

As we steal a ride down in the service elevator, we have a chance to review the building and to contemplate this nine-hundred-thousand dollar contribution of Mr. Charles H. Tompkins to engineering education.

". . complete facilities for the testing of concrete are provided . ."

ALUMVIEWS

PRESIDENT'S MESSAGE

By Warren C. Crump
President, Engineers' Alumni Association

The 1955-56 year has begun in an atmosphere of encouraging anticipation on the part of the Engineer Alumni Association. Several activities are now under way or are being planned to create an even closer bond between graduates of the school and their Alma Mater:

(1.) Engineer Alumni Directory: Working with the office of Alumni relations and the School of Engineering, the Engineer Alumni Association is preparing for publication the Engineer Alumni Directory which, when published in March. will provide a valuable record of our fellow Engineer alumni and will, I think, demonstrate the outstanding caliber of graduates from The George Washington University. Your assistance in locating lost alumni will be greatly appreciated.

(2.) Alumni Symposium: Engineer graduates are urged to celebrate the 1955 Homecoming weekend by attending the Alumni Symposium sponsored by the General Alumni Association to be held in Lisner Auditorium starting at 2:00 p.m. preceded by a buffet luncheon at 12:30 p.m. Dean Martin A. Mason of the School of Engineering will be one of the outstanding faculty members who will discuss the theme "The University Views the Atomic Age."

(3.) Engineer Day: Plans are being made to hold an Engineer Day at the University in conjunction with the annual meeting of the Engineer Alumni Association next February. You will learn more about these activities in coming issues of MECHELECIV.

Meanwhile, the President and his fellow officers call upon each Engineer alumnus to make any suggestions toward the betterment of the Engineer Alumni Association and the School of Engineering. Those officers are:

Vice President -------- Robert P. Lathrop
Secretary-Treasurer ----- John P. Connor
Corr. Secretary --- Wallace G. Kistler, Jr.

ALUMNI NOTES

By the Alumni

BILL GRIFFIN (BCE '49) has been working since May 1954 with Edwards and Green, Architects, of Camden, N. J., as a structual designer. He was president of the Philadelphia section of the ASCE Junior Forum for the year 1953 - 1954.

ARTHUR E. PROCTOR (BEE '53, Sigma Tau) has been working at PEPCO for the past two years and has recently moved into a new home.

E. A BAKER (BSCE '39) has been operating his own construction firm in Takoma Park, Md. since 1946.

LEWIS W. KLOPFER (BSE '31. Kappa Sigma) has completed 42 years of engineering work with the Navy Department's BUSHIPS. He has one son who is in the U. S. Army at Fort Benning, Ga. Lewis' hobbies include radio and minerals.

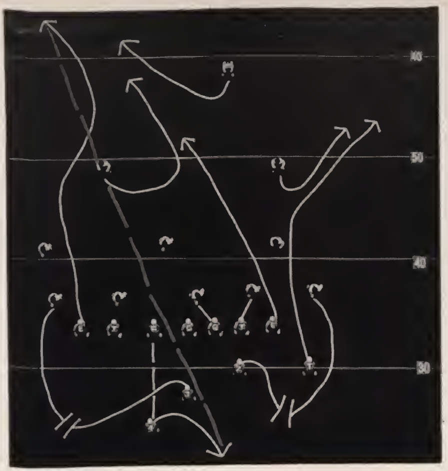
WILLIAM T. ANDREWS (BEE '44, LLM '51) was released from active duty with the U. S. Navy in March '55 and is presently in the New York area.

TO: ALUMNI EDITOR
Mecheleciv Magazine
The Davis-Hodgkins House
731 22nd St. N. W.
Washington 7, D. C.

From:--------------------------------

Here are a few comments for ALUMVIEWS on where I'm working, what I'm doing and news of my family.

Degree and Date ------------------------------ **Fraternity** ------------------------------



aerial attack

Q: What has *this* to do with the aircraft industry —and you?

A: It may have plenty to do with both. Here's how:

Football teams are judged by scoring ability in top competition—teamwork, form, ability, strategy, class. So, too, are aircraft companies.

Martin has created one of the finest engineering teams in the whole world of aviation. And under the new Martin concept of design and development by team operation, every engineering problem—from today's experimental contract to the frontier problems of the future—is the target for a coordinated "aerial attack" by a top-flight team of specialists.

Result: Martin's team operation technique has opened up important opportunities for young creative engineers.

Contact your placement officer or J. M. Hollyday, The Martin Company, Baltimore 3, Maryland.

MARTIN
BALTIMORE

INTERVIEW SCHEDULE

The program of interviews for 1955-56 graduates is already under way. Recruiters from many large companies will be visiting the G. W. campus on the dates listed below. As more interview dates are announced. MECHELECIV will publish them. For further information, students should contact Patricia Coulter in the Student Placement Office.

Martin Aircraft—Mon., November 14

Westinghouse Electric—Wed., November 16

Thieblot Aircraft—Thurs., November 17

Emerson Laboratories—Fri., November 18, Tues., Feb. 7

American Cyanamid Co.—Fri., November 25

ARMA—Mon., December 5

Potomac River Naval Command—Thurs., December 8, Wed., March 14

Sperry Gyroscope—Wed. December 14

Factory Mutual Engineering Division—Thurs., Jan. 12

Kaiser Aluminum (and other divisions)—Fri., Jan. 13.

B. F. Goodrich—Tues., January 17

York Corporation—Mon., February 6

General Railway Signal Co.—Thurs. February 9

Raytheon—Fri., February 10

Bailey Meader—Fri., February 10

Bethlehem Steel—Mon., February 13

Curtiss-Wright—Tues., February 14

Owens-Corning Fiberglas—Fri., February 24

Melpar—Tues., February 28

W. L. Maxson—Tues., February 28

North American Aviation—Tues., March 6

Bureau of Ordnance—Navy — Wed., March 7

Lockheed Missile System—Thurs., March 8

International Business Machines—Wed., March 12

Bell System (Chesapeake & Potomac Tel. Co. Western Electric, Bell Labs, etc.)—Thurs., March 15

National Security Agency—Thurs., March 15

Flight Refueling—Tues., March 20

Columbia Gas System—Tues., March 20

Western Union—Wed., March 28

Lockheed Aircraft—Thurs., March 29

The Automotive Simulator

(Continued from page 7)

nition switch. The fuel quantity instrument is on the dash of the simulated automobile.

The computer is designed about an integrator shaft. That is, the driver uses up fuel at a given rate, measured in gallons per hour. The voltage used to represent this quantity is used as the input signal to the shaft. The shaft runs continuously representing the integral of the voltage as a position of the shaft. The shaft's position is transformed into electrical energy and is used to activate the fuel quantity indicator.

An electronic noise generator is employed to produce characteristic starter and running noises to add realism to the simulation.

When the driver pushes the starter button, 28 volts d-c is fed through the switch to the starter noise generator and to one end of Rl in the starter circuit. As long as the starter switch is held closed the characteristic starter noise is generated, amplified and fed to a speaker under the dash of the car. Also while the starter switch is closed. current flows through Rl and the heater element in the starter delay relay. After six seconds the heater element is hot enough to cause bending in the bimetallic element and the two contacts in the unit close. When this happens 28 volts is fed through the closed contacts to the "engine on" relay K2.

This relay then energizes. If the ignition switch, S1, is closed 28 volts is fed through contacts on S1 and through contacts on the energized "engine on" relay, K2 back to the relay coil. Now when the starter button is released the engine on relay remains energized. This simulates holding the starter button of the actual automobile down just long enough for the engine to start.

The ignition switch performs two other functions. It turns on the filament voltage to the power supply that feeds the fuel quantity indicator. The voltage at the output of the power supply gradually builds up to its full 150 volt level. The fuel quantity meter, being directly affected by this 150 volt supply, also gradually moves up to its proper reading (as it would in a real automobile).

The other circuit controlled by the ignition switch and the "engine on" relays is the 50 volts a-c fed to the accelerator potentiometer R3. The arm of this potentiometer moves directly as a function of the movement of the accelerator pedal. The voltage at the arm of the potentiometer is therefore proportional to the amount of gas fed to the motor. The idle adjustment potentiometer allows a small voltage to be present on the arm of the accelerator potentiometer even before the accelerator is depressed.

The output of the accelerator potentiometer is fed to a motor amplifier, which drives a motor that rotates the fuel quantity shaft. The speed of rotation of the shaft is therefore proportional to the amount by which the accelerator is depressed.

The fuel quantity instrument receives the voltage from potentiometer R8 on the fuel quantity shaft. As the shaft rotates from 0° to 320° the instrument indicates full to empty in a linear relationship.

(Please turn to page 28)

The Face Of The Earth In "3-D"

(Continued from page 9)

The area common to two adjacent pictures is known as the "model" and identical points of the model as projected from two adjacent projectors must be superimposed upon one another. To bring out the three-dimensional effects of the model it is necessary that the viewer see one of the projected photographs with one eye and the other photograph with the other eye. This is accomplished in the same manner as is done with "3-D" movies: the two images are projected in complementary colors and the viewer wears glasses with one lens of each color.

The sheet of paper on which the map is to be drawn is placed on the top of the table, projection lines that define the limiting parallels and meridians of the map are constructed and the control points and other data required by the multiplex operator are plotted thereon. This original map is sometimes known as the "manuscript." A light-weight movable device with a small white circular screen which has in its center an adjustable measuring mark in the form of a "floating" spot of light is placed on the manuscript. This device is known as a "multiplex tracing table." The pictures are projected onto the screen of the instrument and the operator, wearing stereoscopic glasses, is able to see the hills and valleys in their actual perspective. By raising or lowering the small circular screen the operator can place the "floating mark" on a given point and measure its altitude by converting a reading on a scale on the raising or lowering mechanism into feet of altitude. A pencil point for drawing on the manuscript is an integral part of the tracing table and when lowered into position will mark the manuscript whenever the tracing table is moved. In drawing contours on the map, the operator selects a point on the screen at the contour level which he intends to draw, adjusts his "floating mark." lowers the pencil point, and moves the small tracing table to follow along the altitude line selected, thus drawing a segment of one contour line on the manuscript. The simplicity of this method over plotting a series of points along the line is obvious.

In like manner, cultural features of the map such as roads, railroads, transmission lines, and visible property lines are drawn on the manuscript.

The manuscript is then inked to increase legibility and to preserve the copy. This map is then redrawn on linen for reproduction after checking and approval.

The final stage is the completion survey. This is the examination of the completed map in the field before the map is released for publication. The purpose of the completion survey is to delete all undesired information and to obtain and place on the map such information as is impossible to obtain from inspection of the photographs in the office.

The United States, despite the man in the street's opinion to the contrary, is a relatively poorly mapped country in regard to topographic mapping. In the case of the United States and to a lesser degree the rest of the world, this situation is being corrected in the span of a few short years. The bulk of the work is being done by topographic photogrammetry.

The Automotive Simulator

(*Continued from page* 24)

To simulate the engine noise, a portion of the generator's output is rectified (changed from a-c to d-c) and used to control the engine noise. This voltage has to pass through the three can switches before reaching the noise generator. While the fuel tank has gas in it, the voltage passes through cam switches S5 and S6 since these cams are in the position shown. When the tank is almost empty, cam S5 is rotated so that the switch it controls opens and the voltage then passes through cam switch S4. Cam switch S4 bounces up and down in a random fashion. This causes the voltage passing through it, to cut on and off. This voltage, since it controls the noise generator, causes the noise output to go on and off, thereby simulating sputtering of the engine. When the tank is completely empty, cam S6 causes the switch to open, and the noise to stop completely.

The winter-summer switch, S3, when closed shorts out R1 causing the starter delay relay to energize in 3 seconds instead of six, thereby simulating summer use.

The voltage used to operate the engine noise generator is taken from the generator instead of the accelerator potentiometer to add more realism. If the voltage were taken directly from the accelerator potentiometer, the noise would vary directly with pushing the accelerator. This is not completely true since there is usually some time lag before the motor picks up speed. The time lag is present in the generator output so it is used to control the engine noise simulation, thereby providing more realism.

An analog computer is highly adaptable for any device that can be described by means of mathematical equations. The basic principles are simple although relatively new. Nothing more complex than ordinary 60 cycle voltages are used to represent mathematical quantities and the specific mathematical operations are performed by analogy; i.e., the voltages used represent the terms of equations which may be in feet. pounds, second, or degrees.

IN OUR NEXT ISSUE

TOM CRESSWELL, B. S. E. 56, will divulge the scope and intent of his profession: safety engineering. Tom will also give a few tips on just how to get into engineering's newest field.

RAY SULLIVAN will give further proof that the Washington area is not dead for industry with an article on a unique local engineering-manufacturing service.

In the Arma Visual Computer, a single control selects the desired chart from as many as 700 photo slides. Each slide contains punched code holes which automatically tune in the corresponding Omni Bearing Distance station. The image of the plane is governed by a combination of the radio signals and the plane's gyro instruments.

Photography teams with electronics and adds new certainty to flight

Now a visual computer pictures a plane's precise position and heading on projected photos of aeronautical maps.

Arma Division, American Bosch Arma Corp., working with the Air Navigation Development Board and C.A.A., has developed a valuable new aid in air navigation using photography.

With it the pilot, high above the weather, flicks a switch and before him appears a map of the area he's over. On the screen a tiny shadow of a plane moves and shows exactly where he is, where he's heading and whether he's on course.

This spells added certainty. Even more! It can mean savings in time and money, too. For the flight can proceed by plan rather than by dog-legs on the beams.

So again we see photography at work helping to improve operations—doing it for commercial aviation just as it does for manufacturing and distribution.

Photography works in many ways for all kinds of business, large and small. It is saving time, saving money, bettering methods.

This is why graduates in the physical sciences and in engineering find photography an important tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. If you are interested in these opportunities, write to Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company, Rochester 4, N. Y.